RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

Workshop report: Training workshop on communicating weather and climate information with farmers

Same, Tanzania, September 2013

James Hansen

World Vision
Building a better world for children

Training workshop on communicating weather and climate information with farmers, Same, Tanzania, September 2013

Workshop Report

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Abstract

This report describes a workshop that trained roughly 40 intermediaries to adapt this approach in the Kilimajaro region of northern Tanzania. The three-day intermediary training workshop (11-13 September 2015) was followed by a two-day farmer training workshop, which gave a subset of trainees hands-on experience leading the participatory process. The workshops were planned jointly by CCAFS and World Vision-Tanzania. The first three days focused on training professionals who routinely interact with smallholder farmers in the Kilimanjaro region in northern Tanzania. The 40 participants included field staff of World Vision-Tanzania (WVT), agricultural extension officers, and Tanzania Meteorological Agency (TMA) staff. It aimed to equip World Vision staff and the government agricultural extension staff that work with them to bring climate services into the ongoing livelihood and resilience-building activities of World Vision. Six participants from the training for intermediaries were selected to serve as facilitators for a two-day training and planning workshop with about twenty farmers from the surrounding district. The farmer workshop served as a practicum for the intermediary training and provided an opportunity for the participating organizations (agricultural extension, TMA, WVT) to assess the effectiveness of the approach and identify opportunities to improve the process. The report concludes with a number of suggestions for improving the intermediary training, and communication process with rural communities, with a view to upscaling climate services through WVT, TMA and agricultural extension.

Keywords

Climate Change; Agriculture; Food Security; Workshops; Intermediaries; Extension Workers; Training.

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Acronyms

AusAID	Australian Agency for International Development
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
IRI	International Research Institute for Climate and Society
TMA	Tanzania Meteorological Agency
WVT	World Vision-Tanzania

Introduction

Where they are skilful, the use of seasonal climate forecast information offers significant potential to improve farmers' management decisions and livelihoods. However, it also places substantial demands on management skill, as it involves using new information presented in new formats to adjust possibly many interrelated decisions. The probabilistic nature of seasonal forecasts presents a significant challenge – not because farmers have difficulty making decisions in the face of uncertainty, but because formal probability formats must be mapped onto their mental models for dealing with uncertainty.

A number of organizations and initiatives, including CCAFS, use participatory group processes to support farming communities in the interpretation and use of complex climate information. Such farmer group training and planning processes can address many of the known challenges with using routinely available climate information. Evaluations in Zimbabwe (Patt et al. 2005) and Burkina Faso (Roncoli et al. 2009) found that participation in workshop processes greatly increased farmers' use of seasonal forecast information, with substantial spillover benefits to non-participants demonstrated in Burkina Faso.

While researcher-led participatory workshops have proven effective at a pilot scale, they would be difficult and costly to scale up. An attractive alternative is to train agricultural extension officers and other development professionals, to use these approaches to incorporate climate services into their routine interactions with the farming communities that they already serve.

Hansen et al. (2007, 2004a) developed a process to help farmers interpret and respond to probabilistic climate forecasts, expressed as probability-of-exceedance, in a manner that is consistent with the way they deal with variability in the absence of forecasts. This process was the basis for CCAFS pilot activities in Kenya and Senegal (Ndiaye 2011; Ndiaye et al. 2013; Rao et al. 2015). This report describes a workshop that trained roughly 40 intermediaries to adapt this approach in the Kilimajaro region of northern Tanzania. The three-day intermediary training workshop (11-13 September 2015) was followed by a two-day farmer training workshop, which gave a subset of trainees hands-on experience leading the participatory process. The workshops were organized jointly by CCAFS and World Vision-Tanzania (WVT).

Training for Intermediaries

The first three days focused on training professionals who routinely interact with smallholder farmers in the Kilimanjaro region in northern Tanzania. The 40 participants included field staff of WVT, agricultural extension officers, and Tanzania Meteorological Agency (TMA) staff. It aimed to equip World Vision staff and the government agricultural extension staff that work with them to bring climate services into the ongoing livelihood and resilience-building activities of World Vision. The workshops contributed to the project, "Household Resilience in Tanzania," funded by AusAID and led by WVT.

The first day of the training program (Appendix 1) introduced participants to the purpose and overview of the workshops, basic weather and climate concepts, how climate information relates to farm decision-making, and basic principles for working with farming communities on climate information. In breakout groups divided by geographic location, participants were asked to reflect on how climate services can be made effective, by responding to the following questions and reporting back to plenary:

- How can climate services be implemented to benefit farmers in my region?
- What role can I play (as a professional and as an organization) in climate services?
- What is already in place, in terms of climate information and services? What is still needed?
- What mechanisms can foster effective two-way communication between information providers and farmers?

The second day focused on understanding seasonal forecasts, and participatory activities that can help farmers to understand them. The probabilistic nature of seasonal climate forecasts, were emphasized throughout. The training started with an overview of seasonal climate forecasts, a simplified discussion of the basis for seasonal prediction, and TMA's approach to seasonal forecasts. Participants were then led through a series of presentations and activities that equipped them to understand seasonal forecasts expressed as shifts from the climatological probability distribution. The process starts with collective memory of seasonal rainfall characteristics in past years, then moves from time series graphs of seasonal rainfall, to relative frequency, to the historic (i.e., climatological) probability distribution expressed as a probability-of-exceedance graph. Small group exercises ensured that participants could

correctly interpret the probability graphs. El Niño was introduced as a starting point for understanding seasonal forecasts as a shift in the climatological probability distribution. A globe was used to describe El Niño as warmer than normal ocean surface temperatures in the eastern equatorial Pacific. By highlighting past El Niño years in a seasonal rainfall time series graph, and showing the probability distribution for past El Niño years, participants recognized that El Niño conditions tend to shift the probability distribution of the short rains (October-December) toward wetter conditions, but that not all El Niño years have been wetter than normal.

The third day started with discussion about the implications of seasonal forecasts for decision-making by farmers and by local government and organizations. This was reinforced by a participatory Early Warning > Early Action role-playing game, in which groups of participants discussed how they were respond if they represented a particular type of stakeholder and were given a particular seasonal forecast. Five groups were asked to present plans from the perspective of: (a) a farmer in Same, preparing the growing season; (b) a development worker with World Vision Tanzania; (c) a researcher from the regional Tanzania Agricultural Research Institute; (d) an extension officer in charge of providing rural advisories for farmers; and (e) a forecaster from the Tanzania Met Agency (TMA).

The formal workshop program concluded with an evaluation of the training, and discussion of ways it could be better adapted to the local needs. The remainder of the third day was spent preparing for a 2-day seasonal forecast training and planning workshop with farmers.

Practicum: Training for Farmers

Six participants from the training for intermediaries were selected to serve as facilitators for the farmer training workshop. About twenty farmers from the surrounding district participated. The farmer workshop served as a practicum for the intermediary training and a test of the approach. It provided an opportunity for the participating organizations (agricultural extension, TMA, WVT) to assess the effectiveness of the approach and identify opportunities to improve the process. The workshop was conducted in Swahili.

The farmer workshop program (Appendix 2) began with introductions, general discussion of the major challenges they face (to understand the importance they place on climate-related

challenges), the role of climate variability and climate information in their decision-making, and expectations on the part of the participating farmers and the sponsors. Participants discussed traditional indicators that they use to anticipate weather and climate conditions. In other contexts, we found that discussing the traditional indicators that farmers consider in their planning helps to foster trust in meteorological forecasts, and provides a useful entry point to discuss decision-making with uncertain information. TMA then presented an overview of the products that they provide.

The afternoon of the first day, through the first part of the second day, focused on discussion, graphs, and participatory activities using historical seasonal (October-December) rainfall data from Same. The activities were designed to help farmers relate new graphic formats for presenting seasonal climate information to their own experience. The farmers reported their collective memory of the short rains season for the past five years, in terms of crop production (good, medium, poor) and rainfall (high, medium, low). Participating farmers developed a time series bar graph of recorded seasonal rainfall totals, drawn to scale, and validated it against their collective memory. We then led participants through the process of sorting the rainfall series onto a probability-of-exceedance graph, and then discussed interpretation, using analogies of locations that are somewhat wetter (dryer) to aid understanding of shifts to the right (left). Once the participants demonstrated collective understanding of the probability-of-exceedance format, we compared the climatological distribution, based on an extended, time series, with the distribution in El Niño years to convey the notation that a forecast is a shift from the climatological distribution.

The training and communication approach was designed to use seasonal forecasts that are statistically downscaled onto historic station or gridded data, and presented in probability-of-exceedance format. Experience in other contexts confirms that farmers are able to understand and act on probabilistic seasonal forecasts if the forecast is consistent with, and interpreted in the context of, local historic records. As a compromise with TMA's existing conventions for communicating seasonal forecasts, we presented the 2013 short rains forecast in three forms: a narrative, tercile forecast (i.e., the probability that rainfall for the upcoming season will fall in the wettest, middle, or driest third of past years) map (Fig. 1), and downscaled probability of exceedance graph (Fig. 2). The English version narrative for TMA's forecast was (TMA, 2013):

"North-eastern highlands: (Kilimanjaro, Arusha and Manyara regions): Rains are expected to commence in the first week of November, 2013 and are likely to be below normal over much of Kilimanjaro and Manyara regions and southern parts of Arusha region. However, northern parts of Arusha and Kilimanjaro regions are likely to experience normal rains."

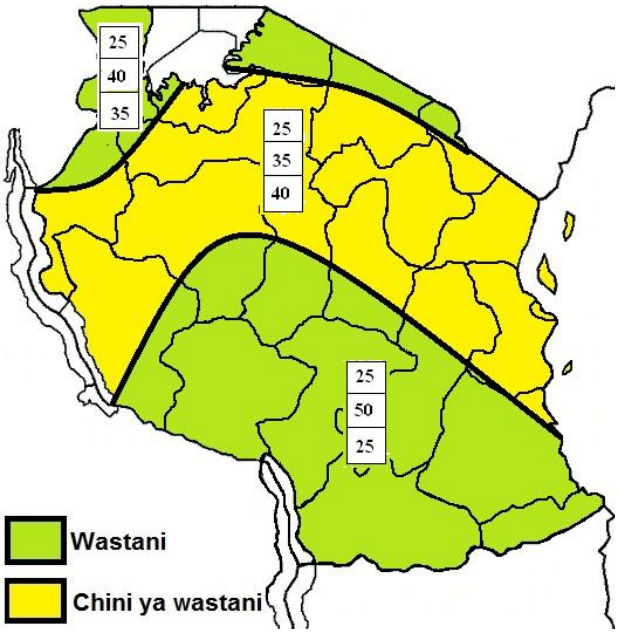

Figure 1. Tanzania 2013 October-December seasonal forecast tercile map. Source: TMA (2013).

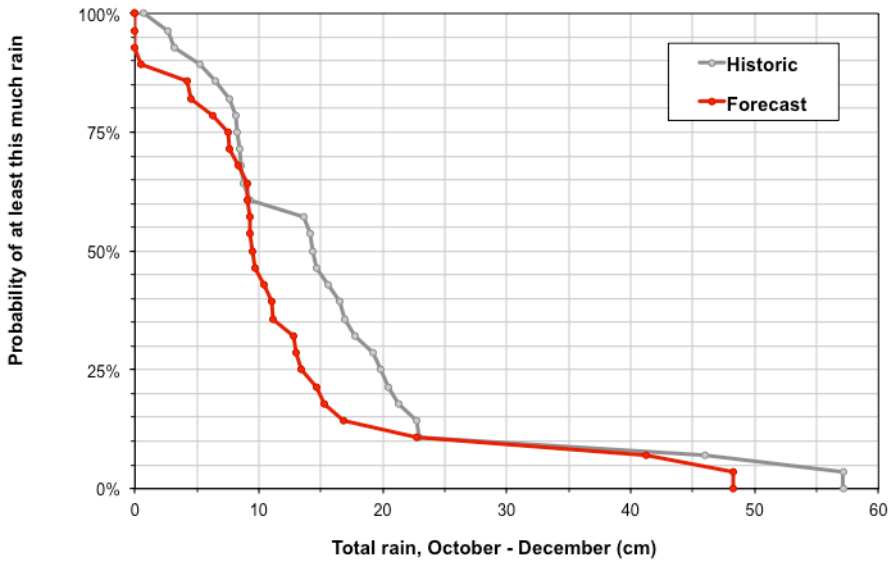

Figure 2: Same 2013 October-December rainfall downscaled seasonal forecast and climatological distribution, based on gridded historic rainfall data for Same.

The remainder of the workshop focused on planning for the upcoming short rains season. Activities included breakout groups to brainstorm about implications of seasonal forecasts for their farm management, the same Early Warning > Early Action game that was incorporated into the intermediary training workshop, and collective development of action plans.

Conclusion and Recommendations

Developing climate services for farmers and pastoralists in northern Tanzania will require parallel investment in developing climate information tailored to needs, effective dissemination mechanisms (to communicators), and training for communicators. The climate service communication strategy will need to be broader than the semiannual seasonal forecast training and planning meetings. It might include, for example, progressive training activities with farmers (possibly separated in time from presentation of the current seasonal forecast), mechanisms for communicating updated and monitored information through the growing season through a combination of interactive radio programming, mobile phone and face-to-face interaction; and a process for responding to demand for additional guidance or support for responding to climate information as needs arise. Mobile phone-based climate information delivery needs more focused attention and planning – particularly for short-lead information, and as a complement to face-to-face interaction with groups of farmers on longer-lead (primarily seasonal) information.

Training workshop for communicators

Based on the workshop evaluation, informal discussion with co-organizers and co-sponsors, and reflection, future trainings targeting the same organizations in northern Tanzania could be improved in several ways. The strong focus on downscaled, probabilistic seasonal forecasts may not have been the right starting point. Training on a new information product that was not routinely available led to some frustration, particularly for those working away from the Same location, which was the source of rainfall data used for workshop exercises and the downscaled seasonal forecast. On the positive side, participants demonstrated a strong desire to access climate information for their locations and put it to use.

Reflecting on this gave me some ideas about how to improve future training for communicators. There is a clear need to develop a more structured training curriculum for

intermediaries. I suggest developing sequential training, with multiple modules and probably a sequence of a limited number of progressive training workshops. The scope should be expanded to include other types and time scales of climate information, such as historic information, additional derived seasonal variables that are important to local agricultural decision-makers, and shorter-term weather forecasts. The first in a sequence of training workshops might include the full range of available climate information products, with overview of how each might support improved decision-making. Training – both for intermediaries and for farmers – should include more time to discuss decisions that climate may influence. A smaller class size, with more interaction, would be more effective. A systematic process for feedback and evaluation should be applied consistently, until the curriculum has been refined and tested adequately. Given the diverse background and roles of participants, more than one training curriculum, targeting different groups of intermediaries, might be warranted. The training and communication process (for both intermediaries and farmers) needs to be coordinated with the availability of locally-relevant information products – particularly since the new downscaled seasonal forecasts, and associated graphical forecasts, are not yet routinely available in Tanzania.

Farmer training and planning workshop

The six trainees from the first workshop who facilitated the farmer workshop took on a daunting task. The six differed in their confidence to train farmers in what they had learned, and their comfort with trying. The three-day workshop may not have provided enough preparation. However, they were invested considerable effort, and managed the process reasonably well with considerable support and guidance from the organizers. They were provided with an outline with detailed notes, particularly on the more technical aspects (Appendix 3). While structured feedback from the six facilitators would have provided valuable information for future training, this unfortunately was not arranged.

The group of farmers demonstrated the ability to interpret the probability graphs accurately, at least as quickly as the professional trainees from World Vision and agricultural extension. This seemed to resolve earlier concerns among some trainees that farmers cannot handle complex information or graphical ways of presenting this information. However, participating farmers seemed to have trouble on the second day, when we discussed the current seasonal forecast in the new format. Although farmers learned to interpret

probability-of-exceedance and time series graphs, neither probability format resonated well for the actual October-December 2013 forecast. The struggle to cover the probability-of-exceedance graphs, and TMA's tercile format and forecast narrative, seemed to contribute to the difficulty.

Some of my suggestions for improving the farmer workshop process are consistent with my suggestions for the training for intermediaries. First, the scope was too narrowly focused, and should be broadened to include more types of climate information, and more discussion about how climate relates to the decisions that they face. Second, two days did not seem to be adequate. A three-day workshop, or multiple meetings totalling at least three days, could be considered. Third, consider separating training on seasonal forecasts (i.e., during a slow period for the farmers), from presentation and planning around the actual seasonal forecast shortly before the start of the growing season. Separating training and planning events might allow more interaction about a broader scope of decision-making during the training. Fourth, consider incorporating games to emphasize that the growing season outcome is like sampling from a probability distribution.

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Appendix 1: Training of Intermediaries Agenda

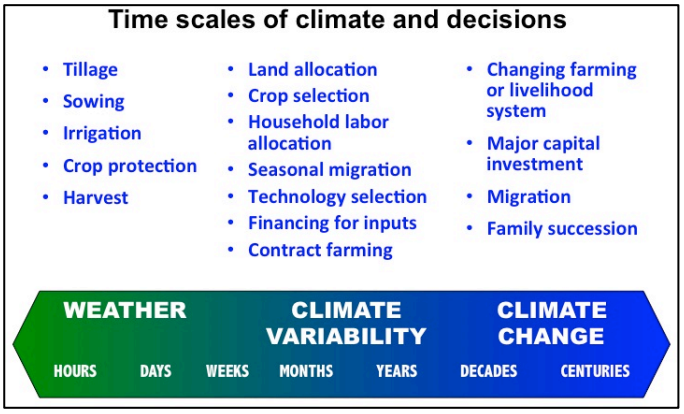
Topics	Lead
Tuesday 10 September	
Introduction, Objectives and Context • Introductions: icebreaker • Why climate services? How climate-related risk impacts farmers. Mechanisms for benefit. • Interest, partnership for scaling up climate services for farmers in Tanzania. Where this training fits into the big picture. • Objectives of training workshop	Arame Jim
BREAK	
Basic Concepts of Weather and Climate Information • Time scales: Weather vs. climate. Weather vs. seasonal climate forecasts, vs. climate change. Relationship to time scales of decisions. • Climate information: Historic, monitored and predicted. Time scales of prediction: basis for prediction, and implications for uncertainty. Standard climate information products that might be routinely available. • Uncertainty, risk and decision-making. How uncertainty affects decision-making. How new information affects decision-making. **Understanding the information needs of farmers** • What we know, some generalizations • What we need to learn from farmers, the context-specific	Jim, Arame
LUNCH	
Basic Principles of Training Farmers to Access & Use Climate Information Services • Climate Services as a process: The National Chain of Climate Services • Key requirements for farmers to benefit from CSs • Participation, co-learning and co-production of knowledge • Participatory principles to build a two-way communication system	Arame
BREAK	
Understanding farmer decision-making under a changing climate: Mapping management implications of climate information services	Arame
Wednesday 11 September	
Seasonal climate forecasting • Anatomy of a forecast • Basis, methods for developing and downscaling seasonal forecasts • Products and services of TMA that are relevant to agriculture • Relationship between scientific forecasts and indigenous indicators. Building on indigenous knowledge to show respect, demonstrate relevance, build trust	TMA staff
BREAK	
Understanding and communicating variability and probability • Rationale for presenting CSs in a probabilistic way. Cognitive and communication challenges with probabilities. • Understanding and graphic past variability • From past variability, to frequency, to future probability. • Interpreting the probability of exceedance graph. • [Analysis of historic weather data?]	Jim

LUNCH	
Seasonal climate prediction • Illustrations and analogies that might help farmers understand. • Why seasonal forecasts are inherently probabilistic. Seasonal forecasts as a shift from the historic/climatological distribution. • Use of ENSO to illustrate to farmers. What would they expect if this were an El Nino year? (Would it work with WV farmers in Tanzania?) • Highlight El Nino years graphically. What does it mean? • Probability of exceedance graph for El Nino years.	Jim
BREAK	
Seasonal climate prediction (continued)	
Thursday 12 September	
Supporting decision responses to climate information The Early Warning > Early Action game	Arame
BREAK	
Farmer practicum preparation • Overview of farmer workshop program • Who is facilitating? • Characteristics and needs of participating farmers • Preparation of graphs, visual aids, EW>EA game cards • Objectives • Eliciting farmer climate service needs • Ensuring participation	Jim
LUNCH	
Farmer practicum preparation (continued)	
BREAK	
Workshop closing • Feedback on value of training, future needs and opportunities • How could training in climate service communication be strengthened and upscaled? • Review lessons, future plans?	

Appendix 2: Farmer Workshop Schedule

13Th Sept	**Activity**
8.30 -10.00	• Socializing / introductions • Challenges facing farmers • Groups: How does climate variability affect them? What difference would information make? • Concepts and terminology • Our objectives, overview • Their expectations
10.00 – 10.20	Tea break
10.20 – 11.00	Groups: Discuss indigenous indicators their reliability and relevance
11.00 -1.00	TMA products
1.00 -1.45	LUNCH
1.45 – 5.00	Memory of past years 5 year time series graph. Discuss: (50 – year time series) • Does seasonal rainfall capture your challenges? Is it changing? • Is seasonal distribution changing? correlation of rainfall and yields
	Implications for further analysis'?
	• Develop a probability graph • Discussion and group exercise to understand a probability graph.
14TH Sept 8.30 – 10.00	El Nino: What do they think it means?
	• Time series graph, discuss • Shifted probability distribution graph
10.00 -10.20	TEA BREAK
10.20 -1.00	Current seasonal forecast • Narrative (words) • Terciles (3 numbers) • Probability graph – curve
	Groups: Discuss management
	Possibly discuss response to wet forecast?
1.00 -1.45	LUNCH
1.45 – 4.30	Early warning – Early Action game
	Action plans

Appendix 3: Farmer Seasonal Forecast Training Agenda and Notes for Trainers

Day 1	
Morning a	**Introductory Session** **Introductions** **Challenges that farmers face** *Brainstorm about the most serious challenges that farmers face. Discuss where climate and weather show up among the challenges that they identify.* **Key concepts about weather and climate information:** • "Weather" has to do with what happens in a particular day at a particular place. • "Climate" refers to longer times and larger regions. (Climate is the "statistics of weather," but I'm not sure whether your farmers will understand what "statistics" means.) Illustrate by contrasting climate (i.e., long-term average temperature and rainfall) between two familiar locations. • "Climate variability" has to do with how seasons (periods of several months, e.g., short rains season or growing season conditions) differ from year to year. • "Climate change" deals with long-term (multiple decades or longer) changes in things like average temperature and average rainfall, which are driven in part by changes in the atmosphere due to human activity. *I suggest a diagram on a sheet of paper. Write time scales (hours, days, months, years, decades) across the bottom. Then discuss what time scales correspond to weather (hours to days), climate variability (months to years) and climate change (decades or longer). Ask farmers to identify some farming decisions that they might change if they had forecasts that they trusted for the next three days. ...for the next three months. ...for the next 30 years. I did this with you on a blank sheet of paper, that was organized something like this:*  *You could also discuss with them how forecasts become less certain the farther we try to predict into the future.* **Objectives and overview of the workshop (maybe in context of the project)** *This seems to be a good point to explain that the purpose of this workshop is to talk with farmers about climate variability, about forecasts for the next rainy season, and about how this type of information might be useful for farm management decisions. To emphasize this, you could circle "CLIMATE VARIABILITY" and the decisions that they said that a 3-month forecast might influence, on the chart you made. A few other concepts are important when we think about climate variability, forecasts and decision-making. It will be important to discuss these concepts in Swahili, and try to find a Swahili word or phrase that everyone agrees on.*

	• "Variability." Deals with what happened in the past. For example, rainfall in 2012 was different from rainfall in 2011, which was different from rainfall in 2010. • "Frequency." Expresses variability with numbers. For example, in four out of the past ten years I was not able to produce enough maize to feed my family until the next harvest. • "Uncertainty." Deals with what will happen in the future. Because the climate has been variable in the past, I am uncertain about what the weather will be like in next growing season. • "Probability." Expresses uncertainty with numbers. For example, there are two chances in five that I will not produce enough maize to feed my family until the next harvest. • "Forecast" (or "Prediction"). A forecast is new information that changes the probabilities about the future. A forecast reduces uncertainty, but doesn't eliminate it completely. We will show how to use probability distributions to describe past climate variability and express a seasonal climate forecast. **Ask farmers about their expectation for the workshop.**
Morning b	**Building on indigenous knowledge** ***SETTING THE STAGE:*** *"As you know, farmers have been coping with the impacts of weather on their livelihoods for a long time. Each season, you farmers must decide how to manage the resources you have available, knowing that there is uncertainty about what the weather might bring in the future. Over the years, you farmers have gained a lot of knowledge about how to manage uncertainty. In some cases, farmers, or other members of the community, such as traditional forecasters, even have methods to predict what the future season might be like or what the weather will be. This is sometimes called "indigenous" or "traditional" knowledge. Now we will take some time to discuss how you use this kind of knowledge in your livelihoods."* ***Step 1:*** *Ask the farmers "Who here has used traditional knowledge about weather to make decisions about their farming practices? Please raise your hand." Look to see how many people have raised their hands. Acknowledge that at least some of the people in the group have raised their hands and that, indeed, indigenous knowledge is an important part of how farmers make decisions in their day-to-day lives.* ***Step 2:*** *Ask the farmers to break into small groups (4-6 people in each).* ***Step 3:*** *Ask each group to discuss what kind of indigenous or traditional knowledge they have used in the past to predict future weather or climate conditions.* ***Step 4:*** *Ask each group to choose 1 example of a way that they, or someone in their community, predicts future weather or climate. (For example: monitoring a specific tree to watch for when the tree starts losing its leaves)* ***Step 5:*** *Using this example of how they use indigenous or traditional knowledge, have each group discuss the following questions (10 minutes):* • *Why do you use or trust this forecast?* • *Have you ever changed your farming practice based on this kind of forecast? What changes did you make?* • *How far into the future was this forecast relevant? (For example: if the tree loses it's leaves now, we know that in about 2-3 weeks it will start to rain)?* • *Do you think that these indigenous or traditional forecasts are "correct" every single time? Are they "correct" most of the time?* • *Do you think that these indigenous or traditional forecasts are working better or worst than they used to in the past? What are the challenges to using these kinds of forecasts?* ***Step 6:*** *Bring the groups back together to share the 1 example of an indigenous or traditional forecast they chose to discuss. Have each group share the responses to*

Questions #1-5 above.

Step 7: *Discuss what the benefits of using traditional forecasts are. Discuss what some of the challenges of using traditional forecasts are.*

Step 8: *Introduce that the idea that over the course of the next two days, you are now going to discuss one more way of forecasting future climate conditions. These new forecasts are just one more tool that can be used alongside indigenous or traditional knowledge.*

DISCUSSION POINTS:

- *This new kind of forecast is just like indigenous or traditional forecasts, because while it useful in helping you to know what is more likely to happen in the future, it is not 100% guaranteed to tell you what will happen.*
- *This new kind of forecast is to be used to COMPLEMENT other kinds of forecasts, NOT to replace them.*
- *Indigenous and traditional forecasts will continue to be useful for their decisions, but there are some situations when this new kind of forecast may also be useful.*

OPTIONAL (if you are ahead of schedule): Forecast and decision analogies

If there seems to be enough time, you could talk briefly about some of the ways that participants use uncertain information outside of farming, and how new information that shifts the probabilities is a form of forecast.

One illustration that might work in some places is guessing (or betting) which team will win a sporting event, such as football. Past record of wins and losses against a particular team (or similar teams) gives an idea of the probability that your favorite team will win the next game. Suppose you learn that the star player on your team (or the opposing team) is injured and can't play. This new information provides a forecast; it changes the probability that the team will win the next game.

In Kenya we tried using the decision about who to marry as an illustration. "X out of 10 single men in my village would make excellent husbands. If a single woman were to chose her husband by putting the names of all available men in a box, and picking one at random, the probably of getting an excellent husband would be x out of 10. However, most cultures have some sort of courtship that allows you to get to know that person better. This reduces the uncertainty, and increases the probability of marrying an excellent husband. However, all of us who are married know that there were some surprises after we got married. ***(One participant told me that this illustration didn't work well in the Kenya culture, because marriage is a very private topic.)***

Introduce TMA products and services

Lunch

Afternoon a

Using Graphs to Understand Rainfall Variability

If possible, try to start this activity before lunch.

- **Memory of past seasons**

Ask participants to classify the short rains season for the past 5 years as good, medium, poor based on crop yields. Repeat in terms of rainfall: wet, medium or dry. Record on a chart. (It might need 2 sheets of paper.) Note and discuss any obvious differences between crops and rain.

Year	Crops	Rainfall
2012		
2011		
2010		
2009		
2008		

Constructing a rainfall time series graph

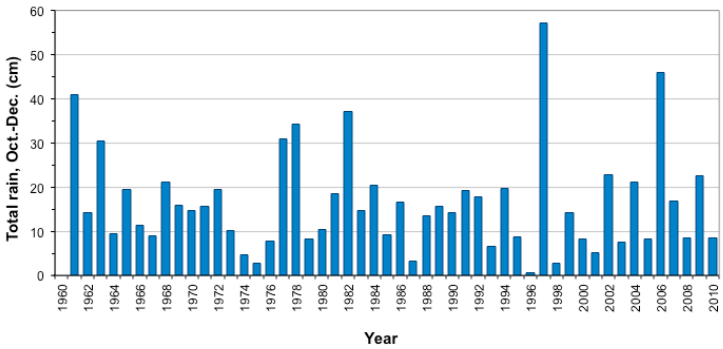
On the chart with farmers' memory of rainfall conditions, write measured rainfall at

Same for each of the past five years. Ask volunteers to take turns marking this rainfall amount on a prepared sheet of paper, with Year and Rainfall axes. Write the amount of rainfall above the mark. Add sides and shading to make a bar graph. Discuss interpretation (as a picture of rainfall depths).

Discuss how the rainfall amounts in the graph relate to they classified those years, in terms of rainfall and in terms of crop yields.

Show and discuss the long-term time series graph.

- What was the wettest year? (1997)
- What was the driest year? (1996)
- How many years had at-least 30 cm of rainfall? (7)
- What are the boundaries between "below-normal," "normal" and "above Normal?



Explain that TMA usually presents its seasonal forecast as three numbers: the probability of getting "above-normal," "normal" and "below normal" rainfall. When TMA uses these terms, "above-normal" means the wettest 1/3 (or 33.3%) of past years, "normal" means the middle 1/3 of past years, and "below normal" means the driest 1/3 of past years (for a specific season, such as the October-December short rains). You can estimate the boundary between "above normal" and "normal" by sliding a horizontal ruler down the graph until you see the top of 17 bars. (17 is approximately 1/3 of the 50 years in the graph.) Read the amount of rainfall on the vertical axis. (We already determined that it is about 19 cm.) You can find the boundary between "below normal" and "normal" by starting from the bottom and sliding the ruler up until the tops of 17 bars are below the ruler. (We already determined it is about 19 cm.)

This is an opportunity to talk about some of the challenges that farmers raised in the first session, that relate to rainfall. For example, if they feel that rainfall is decreasing or drought is becoming more frequent (for the Short Rains), we can discuss whether we can see this in the rainfall data. Note that this graph only shows total October-December rainfall, but crops are sensitive to the timing of rainfall. Do farmers have questions that could be answered by analyzing daily rainfall data more thoroughly, or by looking at temperature or other weather variables? We cannot answer those questions now, but could discuss whether there are some ideas for how to answer them.

Afternoon b

Using Graphs to Understand Probability

Develop a probability graph

Start with a blank graph with quantity (e.g., seasonal rainfall) on the x-axis and frequency (e.g., "Years with at least this much rain," 0 to 5) on the y-axis. Ask volunteers to sort from lowest to highest, and mark the point on the new graph.

For the first point: What was the driest year on the graph? How many cm of rainfall were measured? Out of the five years, how many had at least that much rain? (The correct answer is all 5 years.) Line up the ruler horizontally at 5 years, then measure to the right that many cm, and make a dot. Write above the dot what year it was.

The second point is similar: What was the second driest year? How much rain? Out of 5 years, how many had at-least that much rain? (4 out of 5) Make a dot at the

correct point.

Repeat for the third driest. ...the fourth driest. ...and finally the wettest. The last person to make a dot can also connect all the dots.

Review that relative frequency (in the past) is related to probability (in the future). To turn this graph into a probability distribution, we need to do two things.

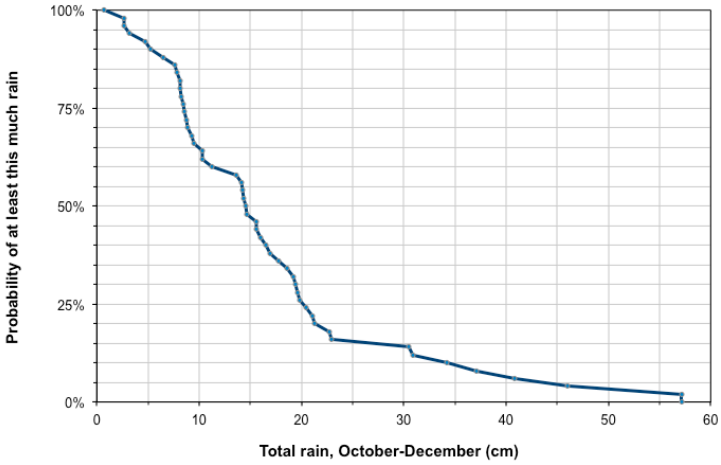
First, we turn number of years (frequency) into percent of years (relative frequency). Probability can also be expressed as percent. Something with a 100% probability will definitely happen. Something with a 50% probability will happen 50% of the times – if you repeat it enough times. Note: we chose 5 because it is easy to calculate the relative frequency (in percent): 5 out of 5 years (5/5) = 100%, 4/5 = 80%, 3/5 = 60%, 2/5 = 40%, 1/5 = 20%. Write these percentages next to the numbers on the vertical axis.

Next, we go from frequency to probability. Write a new label for the vertical axis, next to the old one: "Probability of at least this much rain." (It might be better to explain this after you put up the probability graph printout based on all 50 years of data.)

(Note: Research shows that presenting information as (relative) frequencies rather than equivalent probabilities has a positive effect on many quantitative reasoning or estimation tasks. The frequency of experiencing any climatic category or exceeding any climatic quantity is easily derived from a time series sorted by climatic outcome. We do it interactively for only the past 5 years, so participants understand how it is derived from the time series. This is why we first express the graph as number of years, then percent of years, and finally percent probability.)

Interpret a probability graph

Explain that looking at more years in the past makes the probability graph more accurate. Then show complete probability of exceedance graph, based on 50 years.



Discuss interpretation. This graph allows you to see the probability associated with any given amount of rain, or the amount of rain associated with a given probability.

You could show how it is easier to find the boundary between "above normal" and "normal" with a probability graph than with a time series graph.

Questions for participants:

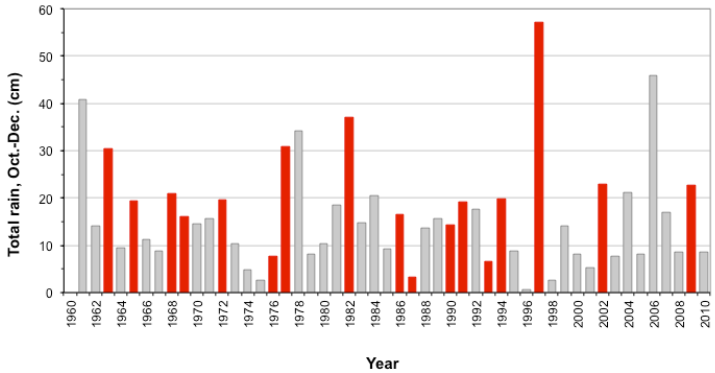
- *What is the probability of getting at least 20 cm? (about 25%)*
- *What is the probability of getting less than 20 cm? (100% - 25%, or 75%)*
- *What is the amount of rainfall in the middle of the distribution, so half of the years are wetter and half of the years are dryer?*

This is probably the most complicated step. Some training and repetition is clearly needed in order for a person to understand an unfamiliar graphic format.

***If we are on schedule, and if participants seem interested**, we can try asking them to break into small groups to work through the same questions, just as we did in our*

	training on Thursday. The graphs on small paper have two probability curves: the grey curve for Same, and a red curve shifted either to the right or two the left. First, ask them to work on the same three questions on their own, and see if they get the same answers. *One way to explain a shift of the climatological distribution to the right or left is to ask farmers to identify and discuss the climate in locations that are somewhat wetter or dryer. But be careful that this doesn't lead to confusion between a forecast that shifts the probability distribution, and a forecast referring to a different geographic location. The appropriate amount of explanation and repetition may depend on the audience.* *Explain: Imagine that we used rainfall data from some other location to develop the red probability curve. Ask them to answer the same three questions for the red curve. What can you say about how the climate there would compare with Same? If time permits, you could ask participants to suggest a location that might have that climate.*
Day 2	
Morning a	**El Niño and Seasonal Forecasts** **Recap, questions (15 minutes)** **El Niño to illustrate seasonal forecasts** *Note: The objective is to show how knowing something about ocean temperatures gives some information about the short rains season in Kenya.* • Farmers' understanding of El Nino *Ask whether farmers have heard about El Nino, and what they understand it means. They might say that it means we will have high rainfall.* • Describe the El Niño phenomenon *El Nino refers to unusually warm temperatures in the eastern Pacific, near the equator. For a long time, Fishermen in Peru and Ecuador noticed usually warm waters every few years. Because it was usually strongest at the end of the year, near Christmas, they called it "El Nino," which is Spanish for Little Boy, and refers to baby Jesus because of Christmas. When meteorologists talk about El Nino, they are talking about something that happens in the Pacific Ocean, on the other side of the world from Tanzania. Use a globe to show locations of Tanzania and the eastern Pacific near the equator.* *El Niño (and La Niña) an important example of how the oceans influence the climate in many parts of the world, including Tanzania. The reason why it is possible to make climate predictions several months in advance is because the oceans affect the atmosphere above them, but the oceans change slowly.* *Only if time allows and if participants seem interested: You can explain that water heats and cools slowly, compared with air. You might use the illustration of seeing how fast your hand will get hot if you hold it above a candle, but a pot of water held above a candle will take a long time to get hot. On the globe, show how, at the equator, the Pacific Ocean goes almost half way around the world. If time allows and if interest is there, you can further explain that warm air rises; but as it rises, it cools. When the air cools, moisture in the air forms clouds and falls as rain. When different parts of the oceans become warmer or cooler, it shifts where these storm clouds form. During El Nino years when the eastern Pacific is unusually warm, the tropical rainfall that usually happens in the western Pacific moves toward the east Air circulates around the world. When you move where air rises and where clouds form, it can shift how these air currents flow, which can influence the climate far from the oceans.* **El Nino has influenced Same (October-December) rainfall**

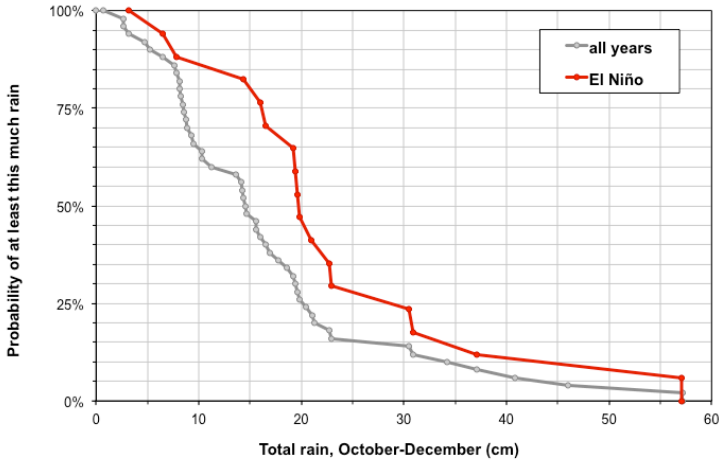
Highlight El Niño years in time series graphs. Discuss how knowing that the next season will be an El Niño would influence their expectations. Participants should recognize that El Nino years have tended to be wetter. They should also recognize that there have been some very wet years that were not El Nino, and that a few El Nino years have been quite dry.



El Nino shifts the probability distribution of Same rainfall

Show the probability graph for all years. Ask participants what they think it would look like if we made a probability graph for just the El Nino years. How would it compare with the graph for all years? If they interpret probability graphs and the highlighted El Nino time series graph correctly, they should predicted that it will be shifted to the right.

Show probability of exceedance graph for Nino years, plotted with the climatological distribution. Discuss how to interpret this type of forecast in terms of shifted probabilities.



This might be a good place to explain that we are working with TMA on developing an experimental downscaled seasonal forecast that is expressed in a similar format, and that we are working with World Vision and agricultural extension officers in this area to see how farmers can understand and make use of this new type of seasonal climate forecast. If so, emphasize that this is not the way that TMA makes their forecast.

Morning b

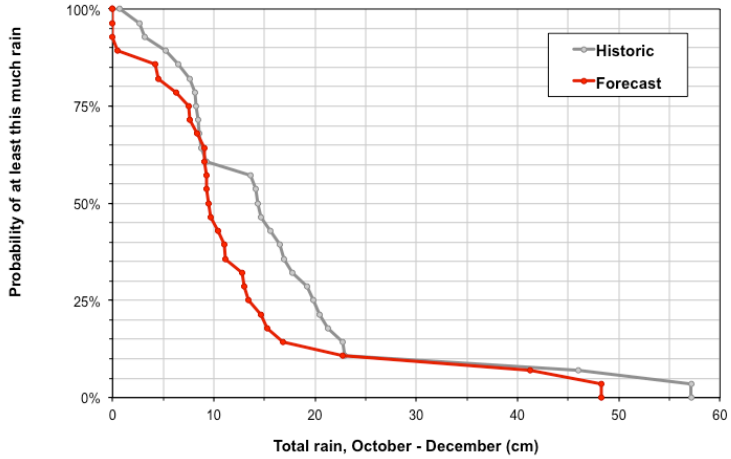
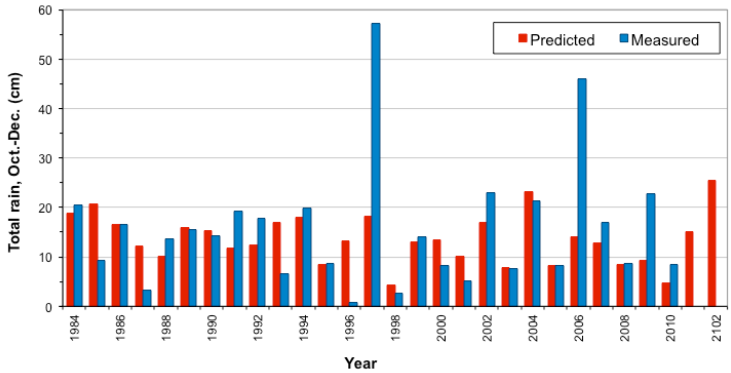
2013 Short Rains forecast

Present and discuss the forecast, in three forms

Mention that we are going to look at a forecast for October-December rainfall in three different ways. MATTHEW IS PREPARING THIS AS A POWERPOINT.

With words. "Normal to below-normal."

With numbers. Give the tercile probabilities. Refer back to the tercile boundaries that we derived either from the time series graph or the probability graph. Discuss what it means in terms of how much the forecast changes the probability of getting rainfall within each of the three ranges. Note that there is still a given probability of receiving above-normal rainfall even though the forecast is expressed as "normal to below-normal."

	Note that both of these ways of explaining the forecast are part of the official TMA forecast, and refer to the same geographic region. Show the map. *With a probability graph. Emphasize that this is an experimental forecast, downscaled to a specific location, and expressed in a new format. It was developed for the purpose of testing how it could be communicated and how useful it is, and for this specific project. Does it seem consistent with the official forecast? (Both predict a moderate shift in the probability distribution toward low rainfall.)*  *Show time series of forecasts with observed rainfall. Note that predicted and measured amounts are not the same, but that years with high predicted rainfall often have high measured rainfall, and hears with low rainfall predictions often have low measured rainfall. Discuss how confident participants would be in this type of forecast system.*  **Group discussion about farm management in response to forecasts** *Break farmers into groups. Ask them to discuss what they will do differently on their farms, in response to this new information. Ask them to write their responses on a large paper, and assign someone to report back to the large group.* *If we are on schedule, this would be a good opportunity to also ask farmers for their impression of the three different type of seasonal forecast. What do they like or not like about each? Which is most useful?* *Report back to the large group. Once groups have presented, discuss their responses, from the perspective of agricultural extension.*
Lunch	
Afternoon	**Early Warning – Early Action game** **Action plans of farmers, and of the 3 institutions leading the workshop** **Closing**